



# Institute for Materials Science

UNCLASSIFIED

## Institute for Materials Science Lecture Series



**Dr. Igor Altfeder**  
**Air Force Research Laboratory**  
**Dayton, Ohio**

**Scanning Tunneling Microscopy of Phonon Standing Waves**

**Tuesday, March 8, 2016**

**2:30 - 3:30 pm**

**MSL Auditorium (TA-03 - Bldg 1698 - Room A103)**

**Abstract:** Previous STM studies of coherent wave processes at the nanoscale have resulted in a number of breakthroughs related to electron standing waves on surfaces. The experimental discovery of atomic scale phonon standing waves opens a new page in this rapidly developing research field. Using scanning tunneling microscopy we observed atomic scale interference patterns on quasi-freestanding WSe<sub>2</sub> islands grown on top of graphene. The double atomic size periodicity of these patterns and the sharp Brillouin zone edge revealed by 2D STM Fourier analysis indicate formation of optical phonon standing waves due to scattering on intercalating defects supporting these islands. Standing wave patterns corresponding to resonant and non-resonant phonon scattering regimes were experimentally observed. We also found the symmetry breaking effect for individual phonon wave packets, one of the unique features distinguishing phonon standing waves. Although phonon detection mechanisms, responsible for these STM observations, are still not fully understood, vibrational and electronic anharmonicities play most likely important role here. A significant contribution to the interference contrast arises from quantum zero-point oscillations.

**Bio:** Igor Altfeder received his PhD in physics from the Kapitza Institute for Physical Problems in 1993. After a postdoc in the Rowland Institute at Harvard and Harvard School of Engineering and Applied Sciences, Altfeder joined the research team at the Air Force Research Laboratory, where he currently works. He began his research career doing STM studies of high-T<sub>c</sub> superconductivity and development of Ultra-Low-Temperature STM (1993). Since 1996, Igor Altfeder has been active in UHV STM of thin metal films and quantum nanostructures, standing electron waves, strongly correlated surface electrons, spin polarized STM, electron-phonon coupling at surfaces, and phonons at the nanoscale. He is a Fellow of the American Physical Society.

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***Hosted by Alexandar Balatsky \* Director of the Institute for Materials Science***